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British Journal of Anæsthesia

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JOHN SNOW AND THE ADVENT OF CHLOROFORM.

By DUDLEY WILMOT BUXTON, M.D., B.S., M.R.C.P.,
Consulting Anæsthetist to University College Hospital.

ALTHOUGH we owe to Sir James Young Simpson the introduction of chloroform, it was Dr. John Snow who first studied and explained the physiological and pharmacological action of that anæsthetic and placed our knowledge of it on a scientific basis. The work of this man, done more than sixty years ago, although it has been amplified and extended, still stands as a monument and example of accurate research. To appreciate Snow's labours at their just appraisement we must know the difficulties which surrounded his undertaking and the narrowness of physiological knowledge in the days in which the enquiry was attempted and brought to a successful issue.

At the time of which we write France led the world in physiological research, but even Majendie, great as he was, was dominated by Cuvier and Bichat, who belittled experimental work and found the road to salvation only along the straight, narrow path of biology. Further, Majendie was a vitalist, and although an indiscriminate experimenter, he failed to recognize that there is no hard and fast line between vital and physico-chemical processes. Johannis Müller, facile princeps in Germany, was essentially a morphologist, while in England the age of experimental physiology was only in its infancy. However, Majendie has to his credit that he proved the accuracy of Bell's guess anent the function of the anterior and superior spinal nerves. Further, by taking for his assistant Claude Bernard he brought the world to a new epoch

of accuracy in research, an accuracy which at times was lacking in his own work. With the advent of Bernard we come to grips with the theme of this paper—the study of chloroform. However, the picture would be incomplete without reference to Jean Baptiste Andre Dumas (1800—1884), who first prepared chloroform from trichloracetic acid and ammonia; to Soubeirau, who adopted the process involved in the interaction of ethyl alcohol and acetone; and to Liebig, using chloral and alkalies.

Marie Jean Pierre Flourens (1794—1867), who has been called, somewhat unkindly, "the showy Perpetual Secretary of the Academy of Sciences," whose work on the semi-circular canals and on the nervous system of vertebrates brought him into touch with chloroform, although he failed to appreciate its utility, being impressed by its dangers rather than by its beneficent powers as an anæsthetic.

So we return to Bernard, who was perhaps the first seriously to consider the properties of anæsthetics. However, his "Leçous" on the effects of toxic substances in which he dealt with ether, carbon monoxide, curari and on anæsthetics in their relation to asphyxia were probably unknown to Snow, and certainly did not adumbrate the practical application of chloroform as an anæsthetic and adjuvant to surgery. Majendie held the view, to us almost incredible, that pain had its uses in surgery. He wrote: "Pain always has its usefulness"; he doubted any advantage "in suppressing pain, by rendering patients insensible during an operation." He adds: "It is a trivial matter to suffer, and a discovery whose object is to prevent pain is of a slight interest only." The writer's father, who witnessed some of Majendie's experiments, used to express his horror of the scientist's callousness to the suffering which he inflicted.

It will be seen from what has been set forth that, so far as physiology is concerned, when Snow took up the subject of the behaviour of anæsthetics but little actual knowledge was available, and practically no formal endeavour had been made to investigate how these agents could be safely employed in the service of suffering humanity. It is true that John Hill Hickman, a country practitioner living in Ludlow, Shropshire, had attempted, early in the nineteenth century, to use ether to

mitigate pain during operations, but his work had been ignored in England and in France. In 1842 Crawford W. Long certainly used ether in surgical operations, and did so successfully, but unfortunately made no public pronouncement of his discovery at the time of his first successes, so that N. T. G. Morton's public demonstration of the successful use of ether in 1846 at the Massachusetts General Hospital was the event which introduced the discovery to British surgeons, and incidentally to John Snow.

In Bernard's writings we find reference made again and again to the difficulties he had to surmount owing to the absence of properly equipped physiological laboratories and a scientific armamentarium. If this was the case in France, which, as has been said, was at this time leading the world in physiological research, it is a tribute to Snow, who, working in England alone and with scant means at his disposal, was able to initiate and complete a unique research. The actual standard of knowledge was low, in spite of the work of Flourens on the nervous system, and Bernard's research on the chorda tympani leading him to believe that vaso-constriction and vaso-dilatation played no unimportant part in the mechanism of the circulation, a conclusion which Brown-Séquard had arrived at at an even earlier date; in spite also of the brothers Ernest and Eduard Weber, who in 1846 had demonstrated that stimulation of the peripheral ends of the severed vagi brought about cardiac inhibition.

These accepted discoveries do not appear to have been associated with any attempt to explain the action of chloroform, and so the clue to the chloroform problem was either ignored or not appreciated. It is true that Bernard formulated his theory, which was that this anæsthetic owed its power to the property it possessed of rendering the brain anæmic, a result as we now recognize as being largely due to vaso-motor action and not simply to the direct influence of chloroform on the nervous tissues of the brain.

Thus we see that Snow had comparative little help from the physiologists of his day. He stands forth as one of the few practical anæsthetists who, adopting the experimental method, learnt the science of anæsthesia underlying the art of inducing a safe management of narcosis.

The life of Snow is more than of passing interest, exemplifying how a keen brain and dogged perseverance can surmount even the greatest obstacles.

Born in 1813, John Snow was the eldest son of a farmer. He spent his early years on his father's farm, receiving a scanty education at a private school in York. At the age of fourteen he was apprenticed to a surgeon, one William Hardcastle, practising in Newcastle-on-Tyne. The Newcastle Infirmary, where he studied, gave him his chance, and he worked with that avidity for the acquisition of knowledge which characterized him throughout life. When seventeen he became a vegetarian and total abstainer, and persevered in a strict regimen for eight years, until his health was seriously affected, obliging him to modify both his views and his practice. The point of interest in his life, and one which demonstrated Snow's capacity for research and clear thinking, was his work at the Killingworth Colliery, where during the terrible outbreak of cholera in 1831-32 he was sent to attend the victims of that dire malady. Although it is somewhat anticipating the events of later years, it may be pointed out that the experience of cholera which he had in Newcastle and Killingworth led him subsequently to publish his contention that cholera was spread through water contamination His views at that time received no adequate recognition, and although his pamphlet which proved the cause of the 1854 outbreak was the pollution of the water supply, was lodged with the judges for the French Institute prize of £1,200 dealing with the prevention of cholera, it was not even mentioned by the judges.

In 1836 Snow came to London and studied at the Hunterian School of Medicine in Great Windmill Street, and at the Westminster Hospital. He took the L.S.A., M.R.C.S., and eventually in 1844 the M.D. (Lond.). He started practice in Frith Street, Soho, without friends and without any influential backing, living the simple life because such patients as came to him were as poor as himself.

Snow never lost heart, and eventually won through. His papers read before the Westminster Medical Society (now the Medical Society of London) at length brought him some recognition, and after various researches, comprising asphyxia

and resuscitation of new-born infants, Snow turned his attention, in 1846, to ether. This agent, after its first trials in London, had fallen somewhat into disfavour. The reason for this is not far to seek. The apparatus employed was crude and wholly unscientific, and an intermittent rather than a continuous system of administration was commonly adopted. Snow at once recognized these defects, and instituted experiments with ether. These enabled him to suggest a more reliable method of etherisation. "When the inhalation of ether," he writes, "was first commenced, the inhalers employed consisted generally of glass vases containing a sponge to afford a surface for the vaporization of ether. Both glass and sponge being very indifferent conductors of caloric, the interiors of the inhalers became much reduced in temperature, the evaporation of ether was very much checked, and the patient breathed air much colder than the freezing point of water containing very little of the vapour of ether." This led to the invention of his ether inhaler, in which metal was used and water employed to prevent freezing. The air was made to pass over a large surface of ether by the use of a spiral volute soldered to the top of the inhaler and reaching nearly to the bottom.

In 1847 Snow published in book form* his researches on ether and an account of this inhaler, and commenced to give demonstrations at St. George's, University College Hospitals and elsewhere. Then came the dramatic introduction of chloroform and the era of Simpson's domination of the whole theatre in which the rival anæsthetics, ether and chloroform, were struggling for supremacy. Snow's work on ether was lost sight of, and his book dealing with it was still-born.

James Young Simpson, the son of a baker, was a man of a compelling personality. In 1847 he was in extensive practice as a surgeon and obstetrician, and had adopted the use of ether in his operations. His essays on this agent and his eloquent appeals to common sense, in which he contested the quasi religious view that the pangs of childbirth are ordained by Providence and so should not be mitigated are too well known to need quotation. However, Simpson found that the smell of ether was unpleasing to

*On the Inhalation of the Vapour of Ether in Surgical Operations.

many patients and was disagreeable to himself as it made his clothes malodorous. He tried various chemical agents. Professor Miller tells us that Simpson, after a hard day's work, would call in his assistants, Matthews Duncan and Keith, and the three would sit at the dining-room table and inhale from cotton wool contained in tumblers. Among the agents tested was chloroform, and its effect was rapidly demonstrated by the three seekers after truth falling out of their chairs and lying unconscious under the table. Curiously enough, no unpleasant after-effects are spoken of; so Simpson adopted chloroform, used it extensively, and introduced it to the world in his paper read before the Medico-Chirurgical Society of Edinburgh, Nov. 1847.

With characteristic energy Snow renounced his research on ether and commenced his historic work on chloroform. It will be convenient to leave for the present the discussion of these experiments and to trace briefly the history of the remaining years of Snow's life.

From 1848 onward Snow divided his attention between experiments undertaken to explain the action of chloroform and other narcotics and the further study of the causation and prevention of cholera. The narcotic series included chloroform, carbon monoxide, carbon dioxide, cyanogen, hydrocyanic acid, "Dutch liquid" or "monochlorurretted chloride of ethyle" (ethidine dichloride), amylene (pental), and puffball, his results being focussed in papers printed in the *Medical Gazette* and delivered before the Westminster Medical Society. He became one of the most respected members of this association of "all the talents," and was in due course inducted into the Presidential chair. Besides demonstrations of the use of chloroform as an anæsthetic given in various hospitals, Snow tried several of the narcotics and their allies, and even ammonia, as inhalations in chest diseases. These were conducted at the Brompton Hospital, and demonstrate his remarkable clinical acumen. He became associated as an anæsthetist with Liston and the other leading surgeons, although it would appear that he never played for self-aggrandisement and was rather forced into this line of practice by the value of his work than by any attempts of his own to exploit his talent.

It is said that Snow's income never rose above one thousand pounds a year, and his simple mode of living underwent no change even when the exiguous days of his poverty had passed. He administered chloroform to Queen Victoria in 1853, when Prince Leopold was born, and again in 1858, at the birth of the Princess Beatrice. The only teaching post which fell to Snow was a brief tenure of the Lectureship of Forensic Medicine in the Aldersgate School of Medicine which he undertook in 1845, although he appears to have assisted in the out-patient department of more than one general hospital. The poor were always with him, and he sought to relieve their sicknesses with loving care.

In 1848 he collected his papers on anæsthetics, and wrote his work entitled "On Chloroform and other Anæsthetics: their action and administration." This was published posthumously under the editorship of his friend and pupil, Benjamin Ward Richardson. As Snow sat correcting his proofs on June 9th, 1858, he wrote the word "exit" and fell unconscious in an apoplectic seizure from which he died on June 17th. Snow had never married. He died a simple-hearted gentleman, a shrewd and accurate observer and one to whom science and truth were as the breath of his nostrils.

LABORATORY AND CLINICAL EXPERIMENTS WITH ETHYLENE AND OTHER HYDROCARBON GASES.*

By James T. Gwathmey,
New York, N.Y.

There are fourteen hydrocarbon gases, namely :—

Acetylene, C_2H_2.
Ethylene, C_2H_4.
Prophylene, C_3H_6.
Butylene, C_4H_8.
Allylene, C_3H_4.
Crotonylene, C_4H_6.
Terene, C_5H_8.

And the vapours :—

Benzene, C_6H_6
Styrolene, C_8H_8.
Naphthalene, $C_{10}H_8$.
Pentane, C_5H_{12}.
Hexane, C_6H_{14}.
Heptane, C_7H_{16}.
Octane, C_8H_{18}.

While all of them have anæsthetic value, just a little more care has to be exercised in their manufacture in order to make them fit for animal and human experimentation than when used for entirely commercial purposes.

If Easson Brown, who read a paper before the Academy of Medicine, Toronto, February 20, 1923, on "Experiments with Ethylene as a General Anæsthetic," or Luckhardt and Carter of Chicago, who published their first paper in the "Journal of the American Medical Association," March 17, 1923, on "The Physiological Effects of Ethylene," merely stumbled upon this gas in an accidental way and proceeded to develop its anæsthetic and analgesic properties without carefully looking into the properties of the other gases, then it may be possible that some other gas of this series will be found later

* Read before the Southern Association of Anæsthetists, Washington, D.C., November 13, 1923.

that is far superior to ethylene in every way. At the present time we must give to Brown, Luckhardt and Carter full credit for introducing a new anæsthetic and powerful analgesic agent.

When it is remembered that chloroform was known for over sixteen years, nitrous oxide for over seventy-two years, ethyl chloride for over one hundred years, and ether for over three hundred years before being used as anæsthetic agents, we can grasp the possibilities and appreciate in a measure what the introduction of a new anæsthetic agent means.

While at least one of the hydrocarbon gases, acetylene (C_2H_2) may prove of even greater value than ethylene, for the purpose of this paper we propose to confine our remarks to ethylene. Ethylene (C_2H_4) is an unsaturated hydrocarbon, is not a highly reactive gas, and is not likely to form compounds in the body. With the conditions under which it would be used as an anæsthetic, it is non-explosive (Brown). Luckhardt uses orthophosphoric acid and alcohol in its preparation. He states that ethylene apparently does not enter into chemical combination with the hæmoglobin of the blood and that it probably exists in the blood during anæsthesia in a state of physical solution. Both Brown and Luckhardt agree that 80 per cent. ethylene and 20 per cent. oxygen is the proper proportion for anæsthetization. "*Blood pressure* remains good even at the end of an hour's anæsthesia." (Brown).

The laboratory work for this paper was done in the Pharmacological Department of the University and Bellevue Medical College under the supervision of Dr. George Barclay Wallace, using white mice and dogs. To determine the comparative value of ethylene we used ether and nitrous oxide as a control. The experiments throughout were conducted from a comparative and practical standpoint and not to decide any detailed physiological or pathological questions. The smaller animals were placed in a glass vessel, in the stopper of which was a short tube leading from the anæsthetic. A glass overflow tube passed through the same stopper and extended to within half an inch of the bottom of the jar. In killing a number of animals first with ethylene and then nitrous oxide without oxygen, there was always sufficient warning with either gas to resuscitate the animal if necessary.

If the animal was taken out before the auxiliary respiratory muscles were brought into play (as indicated by interrupted and gasping respiration) they could easily and always be revived. If a small amount of oxygen was used, the period in which resuscitation could be counted upon was considerably lengthened. Ethylene seemed to affect the brain to a greater degree than nitrous oxide, as indicated by the bulging eyes with death from ethylene. If respiration ceased entirely before the attempt at resuscitation, the result was always in doubt and rarely successful. When oxygen was used the induction was smoother, the maintenance easier, and the relaxation better with ethylene than with nitrous oxide. If a small amount of ether is used with either gas, induction, maintenance, and relaxation are all improved. We did not saturate or double saturate the animals and then continue the anæsthetic, as we consider this an unphysiological process.

With ether and air (or oxygen), induction is slower but maintenance is easier and relaxation is better than with either ethylene or nitrous oxide. With ethylene and oxygen, there seemed to be a tendency to accumulation, or a tendency to sink deeper when the gauges were set at a given place. However, a satisfactory anæsthesia could always be maintained by a slight increase in oxygen after the first few minutes.

Comparatively, nitrous oxide seemed more of an asphyxiant, and the margin of safety narrower, than with ethylene. In order to maintain a smooth anæsthesia a certain amount of cyanosis seemed indispensable with nitrous oxide; with ethylene, the same degree of anæsthesia could be easily maintained with the animal's paws and nose pink at all times. The comparative analgesia was not attempted at this time, but was later determined in the human subject very definitely.

A sufficient number of dogs were used to determine that:

1. With all of the anæsthetics anæsthesia was safer and easier with morphin than without the preliminary, and

2. That an even plane of anæsthesia was easier to maintain with ethylene and oxygen than with nitrous oxide and oxygen.

Before proceeding with the clinical administration the animal experiments were repeated in the offices of M. Ecker, dentist and oral surgeon, in order to convince him that his

patients would be quite as safe under ethylene and oxygen as under nitrous oxide and oxygen. In association with Ecker, over one hundred administrations with ethylene and oxygen were given, and while this is a comparatively small number, they were sufficient to confirm the results of the animal work; and by way of comparison with over 50,000 administrations of nitrous oxide and oxygen, and 20,000 administrations with the same gases passed over a mixture of urethan and paraldehyde in Ecker's previous work, we were able to reach very definite conclusions. The administrations were given with ethylene and oxygen alone, and also with nitrous oxide in sequence and combination. When nitrous oxide and oxygen were used for induction and ethylene added, the induction was smoother but the analgesia was not so great. When the ethylene and oxygen were passed over paraldehyde or essence of orange, the odour seemed less objectionable than when used alone. In only two cases out of the hundred was there nausea and vomiting. The administrations averaged from 40 seconds to three minutes, the longest in this series being seventeen minutes. Each patient was questioned as to nausea, headache, or unpleasant odour, and with only three exceptions the replies were negative. Recovery seemed just a little slower than with nitrous oxide and oxygen, but all were able to walk unassisted from the chair to the adjoining room.

The most important result of this series of cases was the determination of the amount of analgesia. The best results were obtained with an induction of two parts of ethylene and two of oxygen, changing in forty seconds to four parts of ethylene. With this proportion the patient was always pink, and when the operation began there was no movement whatever. If the face mask was used analgesia was present almost twice as long as when nitrous oxide and oxygen was used.

It is a well-known fact that of the four anæsthetics—ether, chloroform, ethyl chloride, and nitrous oxide—ethyl chloride possesses by far greater analgesic properties than the others; yet ethylene possesses as great, or even greater, analgesic properties than ethyl chloride. For instance, with ethylene an extraction can be made either before consciousness is entirely lost or after the return of consciousness without the manifestation of any pain reflexes. Using the nasal inhaler, the analgesia may be continued indefinitely with an active lid

reflex and pink colour. With nitrous oxide the patient may be snoring and slightly cyanosed, yet almost invariably there would be a slight reflex or movement, although the patient would have no remembrance of pain afterward. In this series not a single patient had to be strapped or restrained in any way. In every instance the brain block was more complete than the control case when given nitrous oxide and oxygen, the analgesia appearing earlier and lasting much longer. The finger could be swept around the pharynx without eliciting any reflex whatever, thus suggesting this agent as the ideal one for adenoids and tonsils.

In my clinical work I have not used this gas with oxygen alone, nor do I intend to do so except for short or unusual cases. My own practice is to use a very large mask, about four times the size of the ordinary chloroform mask. Starting the anæsthetic with two parts of oxygen and four of nitrous oxide, I pass this over the surface of anesthol for about two minutes, or until the patient is semi-conscious; then I begin adding ether. A change is then made to ethylene, the anesthol and nitrous oxide being turned off and used no more during the operation. The anæsthesia is continued with two parts of oxygen and two parts of ethylene passed through the ether. Surgical anæsthesia is present in five minutes. A type of anæsthesia ensues that is characterized by extreme relaxation, good colour, pulse, and respiration. Advantage is thus taken of the full analgesic qualities of both ethylene and ether without pushing the patient near the danger zone. I employ this method in gall bladder cases, using ethylene throughout, neither surgeons nor nurses being aware of the fact unless told. The ether completely masks the odour of ethylene. In other short cases the analgesic properties of ethylene have been fully demonstrated. About one-third less ethylene and one-half more oxygen were used in this series than with the usual technique of nitrous oxide and oxygen.

In ethylene we have a most valuable agent and one that is destined to remain with us, provided we can obtain a pure gas and that no attempt is made to use it in an extreme way, that is, using double saturation or discarding ether entirely; remembering always that preliminary medication and a combination or sequence of anæsthetics are, generally speaking, far safer than any single agent.

THE ENDO-TRACHEAL ADMINISTRATION OF NITROUS OXIDE-OXYGEN-ETHANESAL AS THE ROUTINE ANÆSTHETIC OF CHOICE FOR MAJOR SURGERY.

By C. Langton Hewer, M.B., B.S. (Lond.).

THE administration of anæsthetics by the endo-tracheal route has been developed comparatively recently, but the results are so uniformly excellent that it is difficult to see why this method should not be employed as a routine for all cases where the necessary apparatus is available.

Advantages of endo-tracheal anæsthesia.

(1) It is probably the safest known method of anæsthesia, whether general, local, or combined.

(2) It is the only method of producing anæsthesia in which it is certain that the patient's muscles will become completely relaxed without danger. Most of us can recall struggling with a bucolic drayman with gall-stones or the 20-stone lady suffering from bronchitis and an immense umbilical hernia. Such cases render the deficiencies of ordinary inhalation anæsthesia painfully obvious.

(3) It is the only method in which respiration can be suspended for an indefinite time with safety. This is of immense advantage in operations upon the stomach, gall-bladder, lung, etc., where suturing is greatly facilitated.

(4) It is the only method of general anæsthesia in which the anæsthetist can, with safety, keep right away from the patient, knowing that whatever position the patient may have to assume, the airway will always be perfectly clear.

(5) It is the only safe method of anæsthetising patients for extensive thoracotomies in which both pleural cavities may be opened simultaneously, necessitating continuous inflation of the lungs.

(6) A modification of the method (by intra-bronchial catheter) is the only known means of safely anæsthetising

patients with an empyema communicating with a bronchus, so that the pus is not inspired into the unaffected lung.

(7) It is the only practicable way of administering a general anæsthetic for plastic operations upon the nose, mouth, face or neck.

(8) It is the only method of general anæsthesia whereby patients operated upon for acute intestinal obstruction can be carried to a profound degree of narcosis with no possibility of inhaling regurgitated material from the stomach and intestines.

Of these advantages the one which appeals most generally to the average surgeon is the second. It is of no little satisfaction to be certain that a completely relaxed abdominal wall will be the outcome of our administration, and as far as the writer is aware, the endo-tracheal technique is the only one which ensures this desirable result by eliminating all possibility of the laryngeal spasm which so often occurs during upper abdominal operations owing to peritoneal traction.

Disadvantages.

The disadvantages of endo-tracheal anæsthesia are few and can be stated briefly :—

(1) A heavy and somewhat complicated apparatus is necessary.

(2) The expense is somewhat greater than with the simpler forms of anæsthesia.

(3) A good deal of experience is necessary before the anæsthetist can be certain of introducing the catheter into the trachea quickly and without damage to the soft parts and the teeth.

Having discussed the advantages of endo-tracheal anæsthesia in general, the question may now be asked " why use gas-oxygen-ethanesal when air and ether can be given more simply ? " The writer has tried practically every combination of drugs and has come to the conclusion that the one indicated is the least toxic and gives the best results. Furthermore, the technique described below has the advantage that the degree of oxygenation of the blood can be regulated with some accuracy, whereas the use of air limits our control very con-

Photo of actual administration of endo-tracheal gas-oxygen-ethanesal, showing modified Boyle's apparatus.

siderably. The argument that oxygen is a pulmonary irritant can be discounted owing to the fact that it is diluted to practically the same extent as in air, but with nitrous oxide instead of with nitrogen. The fact that the former gas is itself an anæsthetic diminishes the quantity of ethanesal vapour which it is necessary to add to the mixture. It is impossible in this paper to indicate all the reasons why ethanesal is preferred to ether, but the writer recently determined to substitute ether as a control in 100 cases to see whether there was any appreciable difference in the anæsthesia and after-effects. When 20 cases had been completed it was obvious that all these patients had more severe post-operative vomiting than the previous ones, and therefore ether was abandoned. The persons making the reports had no idea that any change in technique had been made, so that a coincidence is extremely unlikely. It is not, of course, suggested that the gas-oxygen-ethanesal combination is incapable of improvement, and the writer is of opinion that the endo-tracheal administration of ethylene-oxygen is superior to it, but as this gas still cannot be obtained in sufficient quantity in England, the former method is recommended as the best that we have at our command at the moment.

Apparatus.

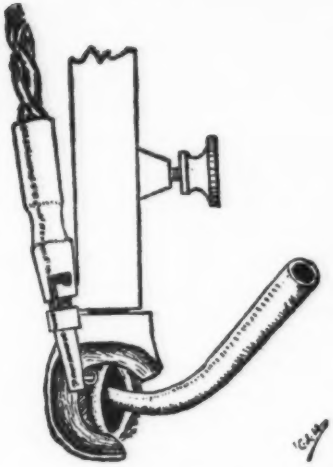
Any standard sight-feed gas and oxygen apparatus can be used without alteration for endo-tracheal anæsthesia, but it is desirable to add an extra anæsthetic bottle and pressure-gauge. The complete modified Boyle's machine can be seen in the photograph (kindly taken by Dr. Clausen), the small standard bottle being used for chloroform and the large tin container with pressure gauge, for ethanesal. Thus any desired combination and proportion of gas-oxygen-ethanesal-chloroform can be administered. Some anæsthetists consider that a safety valve blowing off at a pre-determined pressure, should be fitted. This is unnecessary on Boyle's apparatus as if, by misadventure, a sudden rush of gas should occur, the corks will blow out long before the intra-pulmonary pressure reaches a dangerous level.

A few words may now be said on the somewhat thorny subject of heating the vapour. At first sight this appears to be an admirable proceeding, but the specific heat of gases is

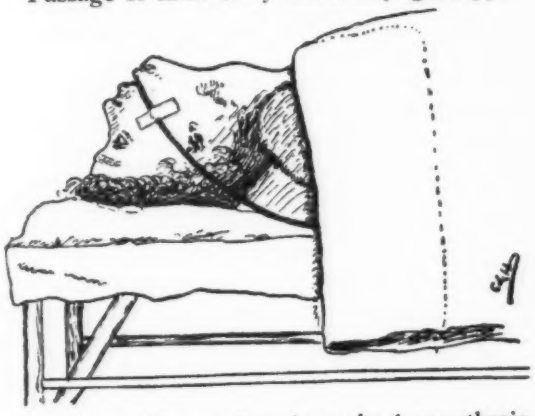
so low that some unlooked-for effects occur. After some investigation the writer has found that if a heater is placed on the machine itself and the exit-tube is more than six feet long, the temperature of the vapour issuing from the end of the catheter is only raised about 2 degrees above room temperature at a normal flow. To secure efficient heating the necessary apparatus must be quite close to the catheter, a circumstance which is usually most inconvenient. If no heater is in action the cooling effect of picking up the ethanesal vapour is lost after passage through about 5 feet of tubing, and the issuing vapour is then at room temperature. Finally, the gases are again heated during the 26 cm. of their passage through the catheter in the mouth, larynx and trachea so that they emerge at the bifurcation of the trachea at approximately body temperature. With an efficient heater interposed near the catheter it was found that patients always perspire, and apparently lose far more heat in this way than they gain by the vapour. Again, it is extremely dangerous to heat vapours containing any chloroform, since this drug when heated in the presence of oxygen tends to decompose into such substances as hydrochloric acid, chlorine, and carbonyl chloride, all of which are irritant and toxic. Finally, there is considerable divergence of opinion as to whether heated ether vapour is actually less irritating to the lungs than that at slightly under body temperature. As a result of these investigations the writer has now abandoned all extra heating.

Technique.

The patient is first given a full hypodermic dose of atropin about half an hour before the induction, and is then completely anæsthetised by an inhalation method. The writer generally uses ethanesal in a Clover's inhaler, but the method most familiar to the administrator should be employed provided that a sufficiently deep degree of narcosis can be obtained. The corneal reflex should be absent, and the jaw muscles completely relaxed before any attempt is made to introduce the catheter. For this reason pure gas and oxygen is unsuitable. Patients suffering from great tracheal obstruction should be anæsthetised with chloroform on a lint as this is less likely to increase the obstruction from congestion, saliva-



Passage of catheter by direct laryngoscopy.



Thyroid position with endo-trachael anæsthesia.

 Thyroid position with towels arranged.

tion, etc. A rough but useful guide to the degree of obstruction is the character of the breathing when the patient is lying flat on his back. If he can then breathe deeply without much stridor or distress, ethanesal can be safely employed.

Difficulty in introducing the catheter can be avoided by attention to the following points:—

Firstly, as has already been indicated, the patient *must* be fully anæsthetised before the introduction is attempted.

Secondly, the patient's head should be exactly in the midline and resting upon one flat pillow. Many anæsthetists seem to think that hyper-extension of the head facilitates the introduction of the catheter. The writer has found that it invariably causes difficulty owing to the stretching of the soft parts, and furthermore, the practice is extremely dangerous when dealing with cervical and thoracic tumours causing respiratory obstruction.

Thirdly, a small direct-vision laryngoscope with a good distal illumination should be used. The epiglottis is first seen and pushed gently forwards, when the vocal cords will come into view. The instrument is then manipulated so that the glottis is in the centre of the visual field as shown in the sketch. If the patient is deeply anæsthetised the cords will be separated far enough to permit of the easy passage of the catheter. If, however, they are in a state of adductor spasm, a pause must be made until they separate. In no case must any force be used, and on the observance of this rule depends the freedom of the patient from post-operative laryngitis.

The distance which the catheter is passed is usually given as 26 cm. from the teeth, but the writer has found that 24 cm. usually gives a better result. The type of catheter used in ordinary cases is similar to the "railroad" urethral catheter, but in cases where one wishes to utilise one lung only (*e.g.*, in empyemata communicating with bronchi) a slightly smaller bicoudé catheter facilitates passage into the desired bronchus and is passed for a distance of about 29 cm. The catheter must be sterilized either in formalin vapour or by a brief boiling.

We now have to discuss the question of the *return airway*. In normal cases it is obvious that the gases escape back along the air passages and pass out of the nose and mouth. If,

however, these cavities are full of blood as in plastic and other operations in the neighbourhood, much bubbling will ensue, which may impede the progress of the surgeon. This can sometimes be avoided by packing, *e.g.*, in a plastic operation on the nose, the catheter is passed through the mouth and the naso-pharynx is completely plugged with a sponge to which a tape is attached. In most plastic cases, however, an *artificial return airway* is desirable. There are various ways of providing for this, but in the opinion of the writer the simplest and best method is to use a double airway catheter. This will be of slightly larger size than the normal single airway type (which averages 16 for an adult) and a length of rubber tubing can be attached to the proximal end of the return airway and led to a position where the escaping vapour does not incommode anyone in the theatre.

Having determined the correct size and distance for the catheter, it is fixed to the skin in any convenient position by adhesive plaster, and is connected up to the vapour supply. Unless the patient is very deeply anæsthetised some coughing will follow this proceeding. In most cases this will rapidly pass off as the gas-oxygen-ethanesal mixture gradually deepens the anæsthesia. If, however, coughing persists unduly, and time is an important factor, the ethanesal should be switched off temporarily and chloroform substituted until the patient is breathing quietly, when a change-over is again made. The proportion of oxygen for normal cases should be started at 25 per cent. and thereafter varied if necessary to keep the colour just pink. Observation of the mucous membranes is unnecessary and indeed impossible if the head is covered up with towels, but the colour of the venous blood in the wound gives the anæsthetist a fairly accurate guide as to its oxygenation. At a moderate degree of narcosis the pupil will be somewhat dilated, reacting sluggishly to light, and the corneal reflex will be absent. The pressure-gauge should register about +5 mm. Hg. on expiration, and 0 on inspiration. If a negative pressure is shown the rate of flow should be increased until zero is reached. An unduly high pressure usually means that the return airway is obstructed and if change of position does not rectify matters a change to a smaller catheter should be made.

If it is desirable to suspend respiration completely the endo-tracheal pressure should be raised to about 20 mm. Hg. This condition can be maintained for an indefinite time provided that no chloroform is being given and that a close watch is kept on the colour, blood-pressure and pulse-rate. In normal cases, however, slight breathing should be permitted, and as a rule, when the correct mixture has once been found, no alteration is necessary for a considerable time. In long cases it is often possible to run on gas and oxygen alone for considerable periods, and in all cases the ethanesal vapour should be switched off about 5 minutes before the end of the operation. It will then be found that when the catheter is removed all reflexes will have returned, and that all traces of ethanesal vapour will have been washed out of the lungs. Patients who are collapsed at the end of operation are often benefitted by the administration of pure oxygen for a few moments before the catheter is withdrawn.

Modifications of Technique.

The technique may have to be varied in the following conditions :—

(1) Cases in which the cautery (actual, electric or diathermic) is to be used on the face or mouth. The only modification necessary will be that the ethanesal vapour should be switched off at least 40 seconds before the cautery is applied. In a long cauterising, gas-oxygen-chloroform should be used.

(2) Operations conducted on the X-ray table, *e.g.*, removal of foreign bodies, setting fractures, etc. The endo-tracheal method is of especial value in these cases as the room being quite dark and extremely noisy, the anæsthetist has little guide as to the colour and respiration of his patient. The risk of explosion from stray sparks is, however, very real, and gas-oxygen-chloroform should be employed.

(3) Patients suffering from severe bronchitis, emphysema, etc., should be given gas-oxygen-chloroform.

(4) Certain plastic and other operations on the mouth in which the presence of the catheter impedes the work of the surgeon. These cases should be anæsthetised by the nasal endo-tracheal method. It is impossible in the confines of this paper to discuss the technique of introducing the catheter

through the nose into the trachea, beyond saying that the simplest method is to use a special pair of forceps (devised by Dr. Magill), although some anæsthetists prefer a probe fitting into a notch on a special catheter.

Contra-indications.

Endo-tracheal anæsthesia is contra-indicated in the following class of case :—

(1) New growths of the mouth, tongue and upper air passages. The writer is of opinion that the risk of introducing particles of growth on the end of the catheter with subsequent septic pneumonia is too great to be ignored, and that a preliminary laryngotomy should be performed. If the pharynx be then completely blocked with a sponge all chance of an inspiration pneumonia will be eliminated. Cases of carcinoma of the larynx will, of course, have to be anæsthetised through a tracheotomy tube.

(2) Babies below the age of one year. The lumen of the glottis is so small in babies that it is practically impossible to obtain a catheter of such size as will permit sufficient vapour to pass and yet leave an adequate return airway.

Results.

The results obtained in the first 1,000 cases may now be briefly summarised. The first 150 administrations were all in severe cases in which the endo-tracheal method was deemed to offer less risk than any other. The remaining 850 were routine major operations, including 250 partial thyroidectomies (the majority being for exophthalmic goitre), and 18 major thoracotomies, the rest being mainly abdominal sections and plastic operations on the face.

Anæsthesia satisfactory with no difficulty or complication in 972 cases (97.2 per cent.).

Deaths during operation, 1 (0.1 per cent.). This occurred during the decortication of a lung and was attributed to damage to the left vagus. It was a typically " reflex " death and was not considered to be due in any way to the anæsthetic. [This case was discussed in the Proceedings of the Royal Society of Medicine, 1923, vol. xvi.]

Pulmonary complications. (1) Fatal, 1 (0.1 per cent.). The operation was a splenectomy for splenic anæmia. The spleen was extremely adherent and several raw areas were left on the under surface of the diaphragm. Two days after operation signs of left basal pneumonia developed. The patient was in a very weak state and gradually succumbed. No post-mortem examination was permitted. Here, again, it is difficult to blame the anæsthetic.

(2) Non-fatal.

(*a*) Broncho-pneumonia, 2 (0.2 per cent.).
(*b*) Bronchitis—severe, 2 (0.2 per cent.).
(*c*) Bronchitis—mild, 10 (1. per cent.).

Post-anæsthetic laryngitis—mild, 4 cases (0.4 per cent.).

Post-anæsthetic pharyngitis, 8 cases (0.8 per cent.).

It may be thought that these figures do not show any appreciable improvement on those relating to other methods of anæsthesia, but nearly all the first 150 patients were extremely bad operative risks, and there is little doubt that if all had been routine cases the results would have been better. Furthermore, in the above list, four patients (one thyroidectomy and three thoracotomies) would, in the opinion of the writer and others, have died during operation if any other type of general or local anæsthesia had been adopted.

In conclusion it may be said that it is obviously impossible to discuss the method at all exhaustively in the scope of this article, but it is hoped that the few general principles which have been suggested may stimulate other anæsthetists to give it a fair trial for themselves.

THE ADVANTAGES OF WARM ETHER VAPOUR.

By Francis E. Shipway, M.D.

THE antiquity of warm ether is respectable. Lawson Tait[1] published in 1883 an account of an apparatus which he had devised for administering warm ether at a temperature of 33° C. in order to prevent the occurrence of bronchitis in old people. The routine method of administration advocated by him was that of dropping ether continuously on to a fold of a towel puffed out around the face at a distance of one inch or one inch and a half. The latter was obviously the forerunner of open ether, and the former of warm ether, but Tait's work was forgotten or not appreciated, and it was left to Davis and Gwathmey to lay the foundation of our modern knowledge of the advantages of this method. It is proposed in this article to bring these forward again[2] as briefly as possible, more especially from the point of view of the diminution of shock and of respiratory complications.

Among minor advantages are noted a more agreeable odour and a lessened irritation of the buccal and bronchial mucous membranes. Induction is more rapid and more smooth, and a successful administration can be conducted without a preliminary injection of atropine (*e.g.*, for catheterization of ureters). Respiration is more quiet and easy, and there is less vomiting, probably because less mucus and saliva are swallowed.[3]

Diminution of Shock.

Reference has already been made to the quieter type of breathing during a warm vapour anæsthesia. This factor is of importance in preventing shock as it represents a saving of energy by the nervous, respiratory and cardio-vascular systems. The chief factor, however, in the prevention of shock is the diminished loss of body heat. The importance of temperature in relation to anæsthesia is seen daily in the precautions taken to maintain the body heat of the anæs-

thetized subject. The regulation of the loss of heat and of the production of heat is abolished during deep anæsthesia; the patient becomes for the time being a cold-blooded animal. Consequently a fall of external temperature diminishes, a rise increases the production of heat. A normal man exposed to cold diminishes his loss by contracting the vessels of the skin and increases the production of heat by muscular activity. The anæsthetized subject has lost this control. Ether anæsthesia may increase the temperature of the skin owing to the dilatation of the vessels, but the loss of heat from this source may be so great that the internal temperature falls. Further, a rise in the internal temperature increases the excitability of the respiratory centre, a fall diminishes it; the heart also is stimulated by warmth, and the exchange of gases between the blood and the tissues is increased. This factor is of importance in view of criticisms to the effect that warming ether vapour does not save more than one calorie per hour.

It must be understood that it is not so much "the actual amount of heat which may be communicated to the patient but the effect of a high external temperature upon the production of heat in the body."[4]

The depth and duration of anæsthesia must be also considered, for it is obvious that deep anæsthesia will have a more profound effect than light, for the paralysis of muscles and the regulation of metabolism are in direct proportion to the depth of anæsthesia. Also prolonged anæsthesia is more detrimental than anæsthesia of short duration. There is consequently less necessity for the use of warm ether for short operations of slight severity, at any rate as far as the healthy adult is concerned, for he possesses a large reserve of heat at the start. On the other hand, in the case of children or of individuals whose resistance and vitality have been lowered by sepsis, trauma, starvation, anæmia or other causes, warm ether is definitely indicated.

Observations upon the superficial (thigh and forearm) and deep temperatures (rectal) during ether anæsthesia have been published by Pembrey and the author.[5]

Open ether and warm ether were used in 67 cases and 64 cases respectively, the two methods of administration being

similar in all respects, except that in the first, ether was dropped continuously on to the fabric covering the mask; in the second warm vapour was blown in under the mask at each inspiration. For full details the paper may be consulted, but it is pertinent to remark here that the greatest fall of rectal temperature in an adult, 2.4° F., occurred with open ether, whereas with warm ether the greatest fall was 1.0° F., and that in 37 cases of warm ether (adults) there were 6 of a fall of 1.0° F. compared with 24 cases of a fall of 1.0° F. or more in 41 cases. The difference in the case of children (4 weeks to 15 years) was equally striking. A few observations upon the temperature of the air under the mask were made; the range in the case of warm ether was 87.8° F. to 93.2° F., in the case of open ether, 48.2° F. to 86.9° F. The fear of producing hyperthermia led the author originally[2] to recommend a temperature of ether vapour ranging between 85-90° F., but subsequent experience in his hands and in the hands of Geoffrey Marshall in France during the war showed that vapour at a temperature of 100° F. can be safely administered in cases of shock. The author's records show no higher rise of rectal temperature than 2.8° F. in a child with a rectal temperature before anæsthesia of 98.6° F., and it is very unlikely that hyperthermia would occur in man, as the mass of the body, exposure during operation and vaso-dilatation would tend to prevent any serious rise.

Our conclusions show that "warm ether maintains the temperature of the body in a far more efficient manner than open ether. Thus with warm ether the respective percentages of rise, fall and no change of rectal temperature were 35.8, 44.5, 19.8 as against 16.6, 76.8, 8.6 with open ether." In other words, "the vitality and resistance of the patient are better maintained under warm ether."

Diminution of Respiratory Complications.

There can be little doubt that the irritating properties of ether play a considerable part in the production of these complications. The choice of anæsthetic for chronic bronchitics, or for those suffering from some sub-acute or acute lesion of the respiratory tract lies away from ether and in the direction of some less irritating agent. This is an admission

that ether is not wholly harmless. It can be rendered less irritating, that is less harmful, by warming the vapour. Also warming the vapour enables the anæsthetist to administer ether at a temperature under the mask which closely approximates to or actually reaches the temperature of the body. Dropping ether on to a mask lowers considerably the temperature of the inspired air. Further, warming the vapour, as we have seen above, tends to maintain the body heat in a far more efficient manner than open ether. For these reasons warm ether has been found to be of considerable value in lessening the liability to lung complications. Bowlby[6] has stated that during the war, when large numbers of men who were already suffering from bronchial catarrh had to be anæsthetized, ether could not be safely administered unless it was warmed, and he strongly advocates its use as a routine method in civil practice.

Marshall[7] noted that in the summer of 1915, of 50 men wounded in the abdomen and surviving more than 48 hours after operation under open ether, 54 per cent. had bronchitis: under warm ether in the summer of 1916 in a corresponding series of cases only 14.7 per cent. had bronchitis. In a communication to the author from France in April 1917, he stated that in one operating unit almost every one of the abdominal patients developed bronchitis after operation, and most of them died. Warm ether was being used but the temperature of the vapour was too low. After remedying this defect 15 of the next 25 cases did well, and not a single one developed bronchitis.

Bigger[8] and Smith[9] speak well of the method; the latter attributes a low proportion of serious pulmonary disease in a series of cases to the use of warmed ether vapour, as prior to its introduction lung complications were considerably more frequent.

Ross[10] thinks that warmed vapours are of benefit in preventing pulmonary complications. The author knows of no series of cases which prove the contrary. It is true that McCardie[11] does not think that warming the vapour has much influence in lessening the liability to lung complications, but it is of interest to note that he lays stress upon the value of respiration through the nose in preference to the mouth on the ground that "the vapour is warmed," and fancies that lung

complications "are less likely to occur after a closed than after an open administration."

Better results can be obtained with the apparatus which the author devised[2] if attention is paid to the following points:

1. The rubber tubing leading to the mask must not exceed 30 inches.
2. No metal connections should be used between the tubing and the mask.
3. The temperature of the vapour entering the mask should lie between 90° and 100° F., according to the type of operation and condition of patient.

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EDITORIAL.

Some Remarks on Post-operative Lung Trouble.

THE intra-thoracic complications that occasionally follow operations offer a problem both to surgeon and to anæsthetist. At present the exact causation of the mischief is often quite unknown. In fact it is often open to doubt whether the anæsthetic or the operation itself is the chief agent in originating subsequent lung trouble. Nevertheless the common assumption is that the anæsthetic is always to blame for these sequelæ. Indeed when ether has been the anæsthetic employed its evil influence upon the respiratory passages is taken for granted and when a comparison is made between this drug and chloroform in point of safety the argument is constantly advanced that though chloroform may lead to death on the table ether is equally dangerous because of the deaths that it causes after operation through "ether pneumonia." Yet when the facts are sifted and evidence for this contention is sought for we find that it is hardly forthcoming. On the contrary we find that deaths through chest complications after operation have been associated with all commonly used anæsthetics. This is true not only of inhaled anæsthetics. These "pneumonia" fatalities have occurred with remarkable frequency after spinal anæsthesia and after purely local anæsthetics. It is clear then that by christening these cases "ether pneumonia" we are begging the question and we are disguising the true facts. Some factor other than the inhaled anæsthetic is obviously involved in the causation of post-operative injury to the lungs. It seems that what is needed in order to clear this matter up is firstly a statement of all the factors involved, and secondly an extended organised investigation designed to settle the relative importance or unimportance of these various factors. In this way it may be possible to narrow down the probable sources of the trouble to one or at the most two main factors, and then our procedure could be carefully designed to obviate these. A broad review of one's own experience of the many reported instances of post-

anæsthtic lung complications leads to a recognition of the following factors as being involved. Any one of them may turn out to be the most important causal agent.

(1) In the first place one would put the site of the operation, because at present that appears to be the most important of all the factors involved. The overwhelming proportion of abdominal operations over all others, except those involving the air passages themselves, is the first striking fact revealed by a study of large numbers of cases of post-operative respiratory trouble.

Space does not permit of a discussion of the way in which an abdominal operation may lead to subsequent lung trouble. Pasteur's admirable work on "massive collapse" has given a clear explanation for many cases. Others are instances of broncho-pneumonic consolidation probably from blocking of small bronchioles and deficient respiratory movement.

(2) Inspiration of organisms, or of material containing them, from the mouth or pharynx. It is here that ether, unless preceded by atropine, is held to play its part through promoting excessive secretion of mucus and saliva some of which may be inhaled with contained germs. Ordinary oral sepsis, which is so common and often so disregarded, must here be borne in mind. In this category come too cases of pneumonia after such operations as excision of the tongue for cancer, when the breath may have to pass over a raw septic surface subsequent to operation.

(3) Pulmonary infarcts. Many cases of "ether pneumonia" have been shown to be really small patches of consolidation subsequent to the infarction of a small embolism derived from some vein ligatured at the operation. These cases are stated to occur most frequently in association with the operation for radical cure of hernia and with pelvic operations.

(4) Pre-existing respiratory lesions. Here one must lay stress on the frequency with which a common cold is afterwards revealed when, lung trouble having followed operation, searching inquiry is made for the cause. Similarly persons recently convalescent from influenza or like affections may be harbouring the specific germ and this may spring into damaging activity when helped by the lowered resistance of

the body, but is almost certain to be caused temporarily by the performance of an operation and the subjection to an anæsthetic. Pre-operative bacteriological investigation should help us to avoid this class of case.

(5) Exposure to chill. It is a common belief that lung complications are much more frequent in hospital practice, when patients have of necessity a considerable little journey from table to bed after operation, than in private practice where it is easier to avoid any exposure of the patient to draughts, cold air or change of temperature.

(6) Direct irritation of air passages by the anæsthetic. Probably ether is the only anæsthetic that can cause trouble in this way. Whether it ever actually does so in practice unless the patient is already affected by coarse bronchitis or other respiratory affection, is still unproven. Experimentally of course the possible damaging effect of ether on the lungs has been shown. The conditions, though, as regards length of administration or concentration of vapour did not coincide with those of the clinical use of ether, and it is doubtful to what extent the laboratory conclusions may be justly applied to human surgery.

(7) Secondary sepsis. When the lung trouble starts more than four days after operation it can generally be dissociated from the anæsthetic. In these cases, which are often grave, the respiratory complication is almost always due to sepsis in connexion with the operation. J. Blomfield.

Reciprocity between Surgery and Anæsthesia.

Members of the profession who have been engaged in our specialty for some years past can hardly fail to appreciate the improvement which has taken place in the relationship between surgeons and anæsthetists, and it will be admitted that the science or art of anæsthesia is so closely allied to that of surgery that without co-operation progress would be impossible. As a matter of fact so intimately do the interests of these two specialties overlap that there is a risk of responsibilities being unwittingly placed upon the wrong shoulders, with the result that progress is sought in the wrong direction. The feeling which prompts these remarks is a consciousness of the debt owed by anæsthesia to surgery, and a desire to

determine at what points friction may still be impeding advance.

The mode of preparing patients for operation varies in different clinics and the matter is apt to be left to routine without due consideration of the factors peculiar to individual cases. The argument is often used that cases of emergency generally show but little tendency to be upset by the anæsthetic although they may have had no preparation, but such results, in reality, support the teaching of anæsthetists who advocate the avoidance both of violent purgation and of too sudden a change in diet, especially where this had consisted largely of carbohydrates, as in hospital cases.

During the course of operation perhaps the most likely bone of contention to arise between surgeon and anæsthetist is the problem as to the level at which anæsthesia ought to be maintained, the interests here involved being often so antagonistic that they call for the most unbiassed consideration. Faulty administration will lead to prolonged and harmful manipulation, just as surely as unskilful handling of the tissues will render artistic anæsthetisation an impossibility. The administrator's plausible attempt to avoid unnecessary saturation with a toxic drug may easily be frustrated by the operator's demand for an unwarrantably deep degree of narcosis, whereas a much lighter degree might be quite satisfactory if the surgical technique were suitably altered or if local analgesia were combined with general anæsthesia.

For many reasons it might be an advantage if the anæsthetist could take a more active share in the care of patients after operation than is the custom generally, not necessarily to make suggestions as to treatment so much as to have impressed upon him the effects of his administration so that he might judge the better what modifications in technique were desirable from his point of view.

Many such " friction points " could be cited, but the above have been selected as illustrating how dual responsibilities may call for singular tact. A. L. Flemming.

To Obtain Proper Relaxation.

Relaxation of the upper abdomen has been the bugbear of many anæsthetists for quite long enough, and any method

that will be of assistance in producing really good relaxation is well worth trying.

It has been known for a long time that endo-tracheal ether can and does produce perfect relaxation of the upper abdomen, but it is only recently that working in conjunction with my colleague, Dr. Langton Hewer, we have evolved a technique which in our opinion is better than endo-tracheal ether.

The combination that we use is either gas-oxygen-ethanesal or gas-oxygen-ethanesal-chloroform.

The patient is anæsthetised in the ordinary way with one or other of the combinations, and taken to fairly deep anæsthesia, the stage one tries to arrive at is relaxation of the jaw muscles, then with the head in the middle line and not hyper-extended a direct vision laryngoscope is passed into the mouth, the epiglottis is tipped forward and a catheter inserted into the larynx. Great care must be taken to carry out this with absolute gentleness for if any force is used there will be bruising and subsequent tracheitis.

Anæsthesia is now maintained by giving one or other of the aforementioned combinations via the catheter, and we find in a large number of cases after the anæsthetic has been in progress for about 15 minutes that gas and oxygen alone are sufficient to maintain adequate anæsthesia, with complete relaxation of the abdominal muscles.

As with endo-tracheal ether anæsthesia the breathing can be entirely suspended, but this is only necessary in a very small proportion of the cases.

Proficiency in this method is readily obtained by any one who has been in the habit of using endo tracheal ether, and it is only necessary to sound a note of caution with regard to the addition of chloroform to the mixture. When this is done the anæsthetist must proceed with great care, using as little of the mixture as possible.

The uniformly good results which have been obtained with this method lead one to think that it might be more widely tried for the difficult upper abdomen. H. Edmund E. Boyle.

The Anæsthetist's Dilemma.

This dilemma faced me recently in the case of a boy, aged 12, with acute appendicitis. He was well developed and, up

to the time of his attack, healthy, with the exception of a rather acute "cold in the head." The question arose, should I administer ether and risk respiratory sequelæ, or chloroform and risk acidosis? I chose the former alternative, and, beyond thirty drops of chloroform during induction, administered ether throughout, giving the warmed vapour from a Bomb led to a mask of the Ogston type. As slight cyanosis developed about half way through, a gentle flow of oxygen was also led to the mask till the finish, the cyanosis rapidly disappearing. The administration lasted for 28 minutes. The appendix was distended, turgid, and kinked, but not gangrenous. The operation presented no unusual features. Twenty-four hours afterwards the patient's temperature commenced to rise, and accompanying this the breathing became rapid and laboured. Eight hours later the patient had all the symptoms of pneumonia; temperature 103.4, pulse 128, respirations 60, short dry cough, embarrassed breathing, and slight cyanosis. Physical examination revealed a left basal pneumonia. This proved to be the height of the attack, and from this time his temperature gradually fell and his other symptoms subsided. Recovery was uneventful and complete.

In making a decision as to the anæsthetic to employ in such a case the anæsthetist has to make up his mind which is the lesser of two evils. (Parenthetically gas and oxygen with local analgesia was probably the method of choice, but in this particular instance I was unable to use it, and it is not always available.) He must decide whether he will risk acidosis which so frequently follows chloroform anæsthesia in acute abdominal conditions, especially in children; or lung complications, which are also more prone to follow ether anæsthesia in children than in adults. In this particular case the abdominal condition proved to be comparatively slight, in that there was no suspicion of gangrene or abscess, and therefore less risk of acidosis. On the other hand I did not know this till the abdomen was opened. The symptoms in such cases are so often deceptive. At any rate the case brought very insistently to my notice a problem which must frequently arise, and one on which the Editor might perhaps allow space for discussion.

H. P. Fairlie.

THE PREVENTION OF POST-ANÆSTHETIC DISCOMFORT.

Some years ago I suggested to the late Mr. Nicoll, surgeon, that the addition of veronal to the rectal salines given to patients after abdominal operations might help to ensure a calming effect and prevent to a certain extent distressing sickness and uneasiness experienced especially after prolonged anæsthesia. The ordinary veronal preparation we found difficult to dissolve although it does so in very hot water, but we obtained much better results with sodium veronal which is readily soluble. After its administration patients could be kept for several days in a more or less drowsy condition and then wake up with no sickness in comparative comfort. The procedure was as follows:—Shortly after the patient was carried from the operating theatre to bed a warm rectal saline of three ounces was given containing 10 grains of sodium veronal, and this was followed every four hours thereafter by a saline containing 5 grains of veronal. If stupor became more than was desirable the veronal could be left out and given alternately. Naturally one can never say how any patient may respond to any drug, so careful observation is requisite. I have found that the best results were obtained in highly neurotic subjects as they are a class who directly they come out of anæsthetic start to retch and make no effort to restrain the tendency to sickness. This applies not only to patients who have had ether or chloroform but also to cases who have had prolonged nitrous oxide and oxygen anæsthesia. I recall a case of a patient who had five abdominal operations and every time had burst the stitches owing to sickness. She was put on veronal after a further operation for excision of the gall bladder and slept for the best part of three days and woke up feeling comparatively well and no sickness. One advantage of rectal administration is that the patient can be kept unaware that any drug is being given. I think that is often an important factor in nervous subjects, for if they get a hypodermic say of morphia, often start worrying in case it may upset them and thus destroy any of the desired good effects.

I have never heard of any untoward results following this treatment, though the stuporous effect produced might cause alarm to any one unaware that it was being employed.

J. PATON BOYD.

ABSTRACTS OF CURRENT ANÆSTHETIC LITERATURE.

La Pressé Medicale, 24th Oct., 1923.

The surprises of chloroform. By L. CHEINISSE.

In recent investigations into the chemical aspects of anæsthesia a Swiss worker, E. Baumann, has come to the conclusion that in a large number of accidents associated either immediately or remotely with the administration of an anæsthetic, the cause is to be traced to a change of a chemical nature having taken place in the drug.

As an illustration he quotes a case reported by Sigal, when a woman, aged 30, was operated on in the Odessa Hospital for appendicitis. The operation lasted 40 minutes, and 50 grms. of chloroform were used; soon after the operation uncontrollable vomiting set in, and two days later the breath still smelt of chloroform and jaundice was noticed, this symptom increased and, coma supervening, the patient died in spite of remedial measures. Three days later, in the same hospital, another woman, also operated on for appendicitis, developed the same train of symptoms, but in a milder form; there was general jaundice, but the patient slowly recovered although some of the symptoms persisted for a long while.

The autopsy on the first patient revealed fatty degeneration of heart, liver, and kidneys.

Samples of the chloroform were analysed and were found to contain organic impurities as well as aldehyde. About this time Sigal learned that accidents, similar to his own, had occurred in different parts of Russia, and as a consequence he was led to examine a number of samples of chloroform. In one American specimen he found organic impurities, aldehyde, and phosgene; and another also contained phosgene; these were both in tin receptacles, apparently from war stocks, a factor which has obtained in the case of many accidents occurring in Russia.

Baumann recommends the following two tests:—

1. Nitrate of silver. No precipitate.
2. Sulphuric acid with trace of formalin. No discolouration.

A Belgian surgeon, H. Magos, has reported four cases who developed cyanosis and tonic spasm of the jaw muscles, with marked respiratory depression when anæsthetised by a specimen of chloroform in which analysis failed to determine what was the nature of the change or impurity present.

La Pressé Medicale, 3rd Nov., 1923.

Poisons which paralyse the sympathetic. By BINET.

Atropine is recognised as a paralysing poison of the vagus system, nicotin of the sympathetic, and adrenalin an excitant of the latter. Swedish physiologists, Backman and others, suggest that atropine is capable of acting on the sympathetic system. And Fredericq and Bardier show that caffein acts as a paralyser of the sympathetic.

Experiments. Backman showed that the contraction caused in an isolated portion of blood vessel, by placing it in a solution of adrenalin, was checked or prevented by the presence of a small quantity of atropine. In the cat, the rise in blood pressure caused by adrenalin was diminished by previous atropinisation.

Béco and Léon Plumier have shown that caffein, by local action, modifies the calibre of vessels, those of the kidney and of the paw becoming markedly dilated. Fredericq and Descamps found that caffein prevented the vaso-constriction and pupil-dilatation which normally take place when the sympathetic of the neck is electrically stimulated.

Other experiments showed that caffein and adrenalin were antagonistic in their action on intestinal circular muscle fibres.

Bulletin de l'Academie de Medicine, 20th Nov., 1923.

Prevention of post-anæsthetic vomiting. By R. BLONDEL.

Vomiting following general anæsthesia is of sufficient importance to warrant our every effort to obviate it.

It is admitted nowadays that vomiting is not to be attributed to the chloroform which may be swallowed with saliva; in the first place this is very small in amount and, moreover, chloroform water is a recognised sedative in cases of nausea and vomiting. Post-anæsthetic vomiting must be regarded as a result of serious injury done to the liver cells by the fat-solvent chloroform brought to the organ by means of the blood stream, and we find that mixtures produce less harmful effects in proportion as they contain less chloroform or ether and as these drugs are replaced by ethyl chloride and alcohol. An unhealthy state of the gastro-hepatic apparatus is probably in most instances the determining factor in cases of alleged chloroform idiosyncrasy.

Since it has been recognised that fasting and purgation may themselves produce acidosis, the method of preparing patients for operation has been modified, and in certain American clinics they are fed freely to within four hours of taking the anæsthetic; but in France the custom is to have recourse to a milk diet with lavage of the bowel.

Departing from the orthodox I have made it my principle to suppress in food all albumen of animal origin, also fats and alcohol, that is to say, any article of diet calculated to impose undue work upon the liver cells; milk has been abandoned because of its casein

and butter; I give for three or four days a régime composed exclusively of bread and fresh fruit, with water, tea, and coffee for drink; with the addition of 8 grammes of citrate or bicarbonate of soda per diem dissolved in aerated water. Each evening the bowel is copiously lavaged.

The result of this routine has been an almost complete freedom from post-anæsthetic vomiting. A. L. FLEMMING.

Rassegna Internazionale di Clinic e Terapia, Anno iii, No. 12.

Dr. R. Riccio has issued from the University of Naples a pamphlet on *points of election for trunk anæsthesia of the sciatic* (peri- and endo-nervous). He employs solutions of novocain from ½ to 3 per cent. which he prefers to make up immediately before use either with distilled water or physiological saline solution, and to them he adds 20 to 25 drops of one in a thousand adrenalin to each 100 cc. of solution. The most simple and least dangerous points at which to make sciatic injections were determined by anatomical dissections and injections of Prussian blue. The gluteal region and the popliteal region are selected. In the first the point of injection lies at the centre of a line drawn from the last sacral vertebra (1.2 cm. above the top of the anal cleft) to the upper margin of the great trochanter. The point in the popliteal region is at the middle of a short line going from the tendinous edge of the semitendinosus to that of the biceps immediately behind the upper angle of the popliteal triangle. With the gluteal puncture the nerve is found at a depth of 2 to 3 cm. according to the individual. The needle is inserted directly on to the sciatic.

Dr. Riccio made a number of experimental injections on dogs before applying his method to the human subject, and the results of these injections are tabulated in the paper here summarized. It was found that perinervous injection, although of course easier in performance, produced an anæsthesia which was less lasting but took longer to appear than that from injection into the nerve trunk itself. An injection of 5 to 10 cm. of 2 per cent. novocain with adrenalin gave an anæsthesia lasting 40 to 50 minutes. The endonervous injections may be, according to Dr. Riccio, either beneath the sheath or into the nerve fibres, and the symptoms produced vary according to which of these sites is injected. Paræsthesia and difficulty of diffusion of the solution distinguish the intrafibrillary injections from those that go merely beneath the sheath of the nerve.

The gluteal injection is made with the patient in the sitting position; for the popliteal he lies prone. Occasionally there is a brief period of shock after the nerve is pierced and this has also been seen during the recovery period after operation. Caffeine injection is recommended as the best treatment.

In "Il Policlinico" Professor Lieini gives some details of his

experience with 300 *cases of spinal anæsthesia.* Among these he had 22 instances of retention of urine, of which 21 were after hernia and one after a hydrocele operation. For the treatment of lowered blood pressure he employed caffein or camphorated oil by subcutaneous injection and obtained good results. The author does not employ spinal for any person with tubercle or other specific infection, and not for children under fifteen years of age.

Dr. B. Quarella contributes to " Il Policlinico " of November some *observations on splanchnic anæsthesia.* He employed the method for eight gastroenterostomies, of which four were on patients with malignant and four on patients with innocent stenosis. Scopolamine and morphia or morphia alone were injected beforehand; the posterior route was used for reaching the splanchnic area with the novocain solution. Twelve operations were performed with splanchnic anæsthesia, and of these the insensibility is described as perfect in eleven and mediocre in one. Bilateral injection was practised in ten, unilateral in two cases. Inflammation of the cellular retroperitoneal tissues and adhesions may interfere with the normal diffusion of the anæsthetic solution and thus cause imperfect anæsthesia. The condition of the patients during severe operations and after compared most favourably with that seen during and after narcosis. The percentage of failures, requiring the assistance of a general anæsthetic, is reckoned by Quarella as about 10 per cent., taking into consideration the results of all those who have reported their cases. Increased experience with the technique will, he believes, reduce this proportion. Injury of the great vessels he finds to be almost impossible, without gross technical error or pathological alteration of the anatomy of the parts approached. Before making the injection the piston of the syringe is always to be withdrawn a little. If blood is then aspirated into the syringe the needle is held to have entered a vessel and is withdrawn somewhat and re-inserted before the injection is made. Acute intoxication from stovaine has twice been reported after injection into the vein. The addition of adrenaline to the novocain is regarded as indispensable. Professor Lieini employs the posterior route of approach, after Kappis.

Dr. Brunicardi in the same journal describes and illustrates an elaborate *apparatus for keeping the lower jaw forward and the mouth open* during general anæsthesia. It is fixed to the back of the head and neck with a pad exerting pressure behind the angle of the jaw and a spring attachment ending in a splint prop to hold the mouth open.

A *history of regional anæsthesia* and a condensed acccount of its application to the various limbs and other portions of the body are given in " Rassegna Internazionale di Clinic e Terapia," Naples, 1923.

J. BLOMFIELD.

Amer. Journ. of Surgery, Anæsthetic Supplement, July 1923.

The anæsthetist's point of view. WM. WEBSTER.

Shock prophylaxis. CHARLES J. WELLS.

*Methods of teaching general anæsthesia to dental students. E. W. MARTINDALE.

*Post graduate in anæsthesia for dentists. HENRY I. DORR and THEODORE D. CASTO.

The value of pressure control re-breathing in ether anæsthesia. J. J. VEGA.

Synergistic analgesia. FRANK D. SMYTHE.

The problem of service in the relation of the professional anæsthetist to the surgeon. ANSEL M. CAINE.

Methods of teaching general anæsthesia to dental students.

In describing the work in the Dental College of the University of Ohio, the author, who occupies the Chair of Instructor in Dental Anæsthesia, details the course required of all students. In the first, second and third years the instruction is given in connection with the departments of organic chemistry, physiology, and dental pathology, and in the fourth and final year one recitation and three clinical hours each week are given over to practical anæsthesia, local and general, in their application to the various needs of dental work.

In the class room the students " are carefully taught the physiological and toxic effect of all the general agents used; how to select the proper anæsthetic with consideration to sex, age, temperament, physical condition, nature and length of operation; how to meet and care for and instruct the patients to gain their confidence; also, how to personally attire and prepare themselves, and prepare the chair, equipment necessary for any emergency, and the operating room; the necessity of quiet assurance and confidence and their effect upon the patient."

Post graduate work in anæsthesia for dentists.

The writer, in this paper, believes that classes should be limited to five graduates, and should include those only who have been in practice several years. An important part of the course is to have each member take small doses of gas-oxygen himself so that he shall know, by personal experience, the physiological effects of the anæsthetic. In a class of five as a working team he gives the following outline of a session's work.

Student 1 should hold the mask and give the gas.

Student 2 should count the pulse and take the blood pressures every three to five minutes and record his findings on a chart, indicating every change to the second.

Student 3 should count the respirations and make records to the second, with general observations as to the conditions of the patient and the procedures in their exact sequences. His chart should show when analgesia, anæsthesia and cyanosis occurred.

Student 4 should arrange the instruments and do whatever is required of him, with ease and dispatch.

Student 5 should be made captain of the clinic. He should assist in every way at the operation and see that each one is supplied with the particular appliance he may require.

GENERAL ITEMS AND NOTES.

Dr. G. E. Macoie has been appointed Honorary Anæsthetist to the Bradford Royal Infirmary.

The Seventy-seventh anniversary of Ether Day was celebrated at the Massachusetts General Hospital, Boston, on October 15th and 16th.

Mr. S. R. Wilson, F.R.C.S.E., delivered a post-graduate lecture at the Manchester Royal Infirmary, Nov. 14th, taking as his subject "Recent Improvements in Anæsthesia."

Soupault and Boulanger-Pilet, in the *Paris Médical*, Sept. 29th, 1923, mention a case of meningitis following lumbar intraspinal anæsthesia which, however, recovered in eight days.

The Laryngological Section of the Royal Society of Medicine held a joint meeting with the Anæsthetic, Odontological and Otological Sections on Dec. 7th at which "The Comparative Value of Cocaine Substances" was discussed.

On the programme of the Congress of Anæsthetists, Chicago, Oct. 22—24, Mr. Z. Mennell, M.B., M.R.C.S., of London, was down as the representative of the Section of Anæsthetics, Royal Society of Medicine, to read a paper on "Anæsthesia for Intracranial Surgery."

C. Ritter, in an article in the September 8th *Zentralblatt für Chirurgie*, points out that by compression of the carotid arteries at the inner margin of the sternocleidomastoid muscles anæsthesia with ether may be hastened by producing cerebral anæmia.

The following officers were elected at the annual meeting of the National Anæsthesia Research Society held in Chicago, Oct. 22—24th: President, W. I. Jones, D.D.S., Columbus, Ohio; Vice-Presidents, Drs. John H. Evans, Buffalo, N.Y., and Arthur E. Guedel, Indianopolis; and Secretary-Treasurer, Dr. Frank H. McMechan, Avon Lake, Ohio.

At the Birmingham Meeting of the Anæsthetic Section, Royal Society of Medicine, Dec. 1st, Dr. K. B. Pinson of Manchester exhibited the apparatus with which he had conducted experiments in the condensation of dimethyl ether. This substance at normal pressure and temperature is a gas. He found that it boiled at $-24°C.$, and that at $100°C.$ it exerted a pressure of 97 lbs. to the square inch, and could thus be safely stored in cylinders.

At the recent Congress of the Associated Anæsthetists at San Francisco resolutions were passed committing themselves to the development and extension of the specialty of anæsthesia and the standardization of anæsthetic service in the hospitals of the United

States and Canada. A committee is to be formed to collaborate in compiling and publishing a pamphlet to bring to public attention the importance of such an innovation.

The new terms of service for insurance practitioners, commencing as from Jan. 1, 1924, make the doctor responsible for providing the service of another practitioner for the administration of an anæsthetic, when necessary, in connection with an operation undertaken under the terms of service. Exception is made in the cases of those who, as a result of special skill and experience, may be placed in the category of specialists.

The Supreme Court of Pennslyvania, in the case of a claim under the Workmen's Compensation Act, affirmed an award for compensation for a death under anæsthesia which was administered for treatment of a compound fracture of the right index finger. The Court held that the injury caused the operation, the operation required the anæsthesia, the anæsthesia brought about dilatation of the heart, and the latter caused the death, thus establishing a causal connection between the original violence and the death which ultimately resulted.

E. House (*Am. Journ. Surg. Anæst. Supplement*, Oct. 23), in an article on Scopolamin Anæsthesia in Criminology, claims that he is able, by the use of this drug, " to secure from the mind, against its will, the stored contents called memory." He states that, since the hearing centre is the last to succumb to an anæsthetic and the first to function after its discontinuance, it is but necessary to put a question to an individual at this exact period, that is, at the moment the auditory centre asserts its power, to elicit a truthful reply, the individual being too helpless to protect himself by inventing lies to the question propounded. He calls this period of borderland anæsthesia the *receptive stage*. Scopolamin, he asserts, is peculiarly fitted to produce this state of mind, and he gives instances where criminals related facts which, though against their own interests, were later checked by verifying testimony. He believes that its judicial use might also prevent the miscarriage of justice in the case of innocent victims.

In a paper on Obstetric Analgesia (*Journ. A. M. A.*, 29, 9, 23) Danforth and Davis conclude that ether, unless contraindicated, is the inhalation anæsthetic of choice for the longer operations during pregnancy and labour. Nitrous oxid-oxygen may be used for examinations and short operations, as well as for intermittent analgesia during the second stage of labour. They believe that chloroform should be " completely discarded."

In a paper on Local Anæsthesia, same journal, Farr sums up the important features necessary to success in that method as including " attention to the psychic condition of the patient; the establishment of careful pre-operative diagnosis; the painless, thorough induction

of anæsthesia of the abdominal wall; elastic retraction; perfect exposure; the establishment of anterior splanchnic anæsthesia, when indicated; the enlistment of the patient's co-operation, and the application of a surgical technique that is compatible with this method of anæthesia and the best interests of the patient."

Bonar and Meeker of Rochester, in their paper on Sacral Nerve Block Anæsthesia in Obstetrics (same journal), state that labour pains may be entirely controlled by block of the second, third, fourth and fifth sacral, and anococcygeal nerve, the epidural method being most practical. Also most operative and manipulative obstetric procedures may be painlessly performed under sacral nerve block; the only drawback being the comparative shortness of its duration.

Dr. Henry Featherstone communicated a critical report on 100 cases of spinal analgesia with tropacocaine, at the Nov. 2nd meeting of the Anæsthetic section, Royal Society of Medicine. The author's conclusions were as follows:— (1) Patients suffering from diseases of lungs, heart, kidneys, chronic toxæmia and diseases of metabolism may well be treated by intrathecal methods. (2) The presence of acute traumatic shock is a contraindication. (3) The method does not prevent abdominal shock associated with severe handling of a viscus above the colon without very high paralysis. (4) Exhaustion from manipulation of the pregnant uterus in labour and of the pelvic organs in general is rarely seen. (5) Association with light general narcosis is most helpful. (6) Early post-operative headache rarely occurs with tropacocaine, provided that there is little loss of cerebrospinal fluid. (7) The most careful handling of these cases is needed if a considerable fall in the blood pressure is to be avoided. (8) Late complications attributable to the spinal anæsthetic are extremely uncommon in the absence of infection.

Dr. T. B. Vaile will deliver a post-graduate lecture at the Cancer Hospital, Kensington, S.W., on "Surgical Anæsthesia by Nitrous Oxide and Oxygen," at 4-30 p.m., Feb. 13th.

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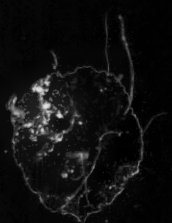

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